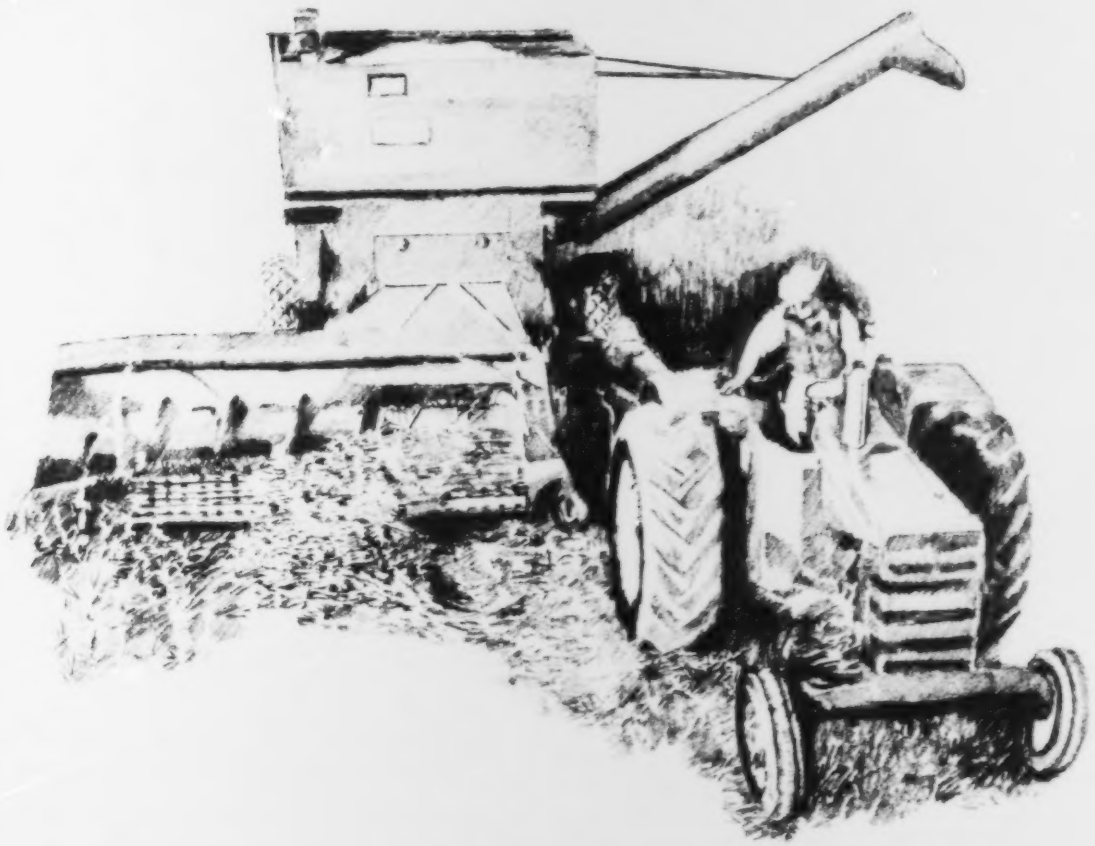
Farm Machinery Economics



FARM BUSINESS MANAGEMENT

Canada AGRI·FOOD Manitoba

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Farm Machinery Economics

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Introduction to Farm Machinery Economics

Background

Farmers need machinery and equipment in order to carry on their farming operations. A full line of modern efficient machinery makes the jobs easier and results are often better.

There are many reasons for a farm manager to upgrade and expand a line of machinery. Most machines are labour saving. An operator with bigger or more efficient machines will simply get more work done in less time. Some newer machines have hydraulic and electronic features that allow a spouse or younger family member to join the farm labour force as an operator of that machine. Improving the availability of labour through adding machinery makes good sense if there is a labour shortage or an alternative use for existing labour.

Farmers can also save or cut down on income tax payable in a specific year with a new machinery purchase (e.g., increased Capital Cost Allowance). This, however, needs to be considered within an overall tax management strategy. The strategy must consider all the long-run implications for future taxable positions as well as added ownership and operating costs of purchasing the machinery asset and their effects on the farm's cash flow position. The manager needs to be careful that tax benefits or savings exceed any additional costs experienced by the business due to the purchase.

Production performance can be improved by newer and/or more machinery. The timeliness of task completion may be improved, resulting in increased production. Cultivation and other cultural practices can be carried out more effectively and better yields achieved. Animal handling and husbandry can be carried out in a way that improves herd health and performance. Having the machines and equipment to perform tasks well and when they need to be done gives managers more control over production activities. Achieving higher production levels and the improved working conditions that go along with more and better machinery can also provide a great deal of personal satisfaction.

Reasons to add to and improve the farm machinery line are abundant. All relevant costs need to be taken into account, however, before the improvement can be justified.

Purchasing machinery assets with the farmer's own capital takes that money out of the business and ties it up for a long time. The manager loses the opportunity to put those dollars to work where they could possibly bring back a greater return than the machine is providing. Meanwhile, the asset purchased with this capital loses value, wears out or becomes obsolete and eventually has to be replaced.

If the farmer makes the purchase with debt capital, the machine will be pledged as security. Additional assets may also be required as security. Generally, lenders will require collateral well in excess of the loan, thus restricting the manager's ability to raise debt capital for other enterprises. Repayment commitments go along with new loans and the business must generate adequate cash to meet obligations. If added loans place the business into a tight cash flow position, the

manager will have less flexibility regarding any decision affecting business liquidity.

Each farm machinery decision must be looked at as an investment. Because capital is required when the investment is made, and costs and returns accrue over a longer time period, the machinery decision becomes a rather complex problem of deciding on a long-term investment. Furthermore, there are alternative methods of acquiring the asset, such as outright ownership or leasing, and alternative means of financing the investment.

Evaluation procedures have been developed to help managers make informed, well thought out farm machinery decisions. It is worth the time and effort to utilize these procedures as poor machinery investment decisions can put the financial health of a business in jeopardy. If returns from additional machines do not generate cash faster than added debt repayment requires it, cash flow problems will develop or worsen. If ownership and operating costs are greater than added income attributable to the additional machinery, net income or profit will decline. If the loss in asset value, as machines wear out and become obsolete, is greater than added income that gets invested back into the business, the business net worth will decline and the farmer will lose wealth. If the farmer considers all relevant information and procedures available for making machinery decisions, the chances of these problems occurring are reduced.

Purpose of Publication

This publication is intended to assist farmers evaluate investments in farm machinery. It will sort out those costs and returns that need to be taken into account, and develop ways to compare dollars leaving or entering the farm business at different time periods. It will also provide ways to compare different ownership and financing alternatives as they affect profitability, liquidity and the farmer's wealth or equity in the business.

Investment evaluation will be introduced through a budgeting procedure, developed later in this publication. This procedure is well suited for machinery investments where capital costs, operating costs and returns generated from the investment take place over several years. The process estimates net returns from an investment where the farmer specifies his particular circumstances regarding price paid, method of ownership, method of payment, operating costs and expected returns. The expected returns are projected over the lifetime of the asset. These expected benefits result from improved yields and grades due to more timely and precise operations, ability to expand the size of operations, and efficiency savings in labour, energy or other operating costs. The budgeting framework developed in this publication allows all the above factors to be taken into account in the overall analysis.

The publication also identifies ways of having access to farm machinery other than outright ownership. Besides the overall cost of these alternatives, the availability at critical times, liability for maintenance and any unusual circumstances all need to be considered. The budgeting procedure developed in this publication will be used to compare such alternatives. The effects of each alternative on business liquidity, solvency, and the carrying out of day to day farming operations are also identified and evaluated.

A further objective of the publication is to outline information

helpful for some basic decisions that need to be made before one gets to the actual investment evaluation. Information is provided to help choose a machine of the right size or capacity to match the acreage, cropping program and time and labour available to carry out the job. It will also deal with the potential to share machines and the advantages and disadvantages that go with joint access to machinery.

There is also a section devoted to machinery replacement strategies (i.e., when should a farmer trade) that will allow a farmer to evaluate several replacement options with respect to costs, benefits and tax implications. A discussion of investing in used versus new equipment is included in this section.

The publication provides a means of measuring the effects of a machinery loan's terms on its cost. This allows farmers to compare and evaluate different financing options for their machinery investments. Implications of collateral used for security on machinery financing are also identified.

Costs of Owning and Operating Machinery

Introduction

A farmer makes the decision to purchase one machine rather than another based on expectations of performance, durability, cost efficiency and the initial investment cost. Similarly a farmer decides whether to purchase that machine or to obtain access to it through some other contractual arrangement based on the same set of factors. In reality all of these affect the overall cost of owning and/or operating the machine. The total cost picture must be taken into account when making a machinery decision. It is also important to distinguish between the costs of owning and the costs of operating the machine.

Fixed Costs

Fixed costs are the costs of owning a machine and are often called ownership costs. Once the machine is purchased, the farmer has little control over the level of ownership costs. These costs can, however, be spread over more acres or units of production (e.g., cows, sows), resulting in lower ownership costs per unit of output (tonnes, weanlings, etc.). There is a limit to how far this cost reduction can go. As the asset is required to service more and more units of production, tasks are not done as well or on a timely basis and lower yields or production levels offset the savings.

Depreciation

Depreciation is an important fixed cost. **Economic depreciation is the allocation of an asset's original cost over its useful life in a way that reflects the rate at which its services are used in the production process.** Depreciation also reflects the loss in value of an asset due to wear and tear, obsolescence, etc.

If a new machine provides more service than an old machine it makes sense for the depreciation cost to be higher when the machine is new and lower when it is old. A method to achieve this is called

declining balance depreciation, and is calculated as follows:

$$\text{Annual Depreciation} = \text{Book Value} \times \text{Depreciation Rate}$$

In the first year, the book value of the machine is the original cost. The beginning book value for all other years is calculated as the previous year's beginning book value less the previous year's depreciation. Depreciation is calculated for each year until the value of the machine has been reduced to some predetermined salvage value.

The depreciation rate used in declining balance depreciation calculations remains the same over the life of the asset. An appropriate rate to use is one that will prorate the entire original cost down to the salvage value during the expected life of the asset. These rates generally fall between 20 percent to 30 percent for power machines, 10 percent to 15 percent for tillage machines.

If the machine's services flow evenly, the same depreciation cost should be taken in each year of its lifetime. This method is called straight line depreciation, and is calculated as follows:

$$\text{Annual Depreciation} = \frac{\text{Original Cost - Salvage Value}}{\text{Years of Useful Life}}$$

The resulting value is the depreciation cost to be used in each year of the machine's lifetime. Table 1 illustrates annual depreciation costs, for both methods, that could be used for planning a machinery investment.

Depreciation cost represents a non-cash cost for the farm operation. In a practical sense, then, they are funds that may be set aside for use in personal consumption or reinvestment in the farm operation. The use made of these funds has consequences when considering replacement of the asset. If the funds are reinvested, and earn an adequate return, there will be equity capital in the business to replace the present machine once it has exhausted its usefulness. It is therefore important to take depreciation into account when making decisions as to the use of funds coming into the business.

The other time that depreciation becomes important in the decision making process is when the manager is planning for investment in a depreciable capital asset. At that time a manager is imposing a cost onto the business that must be met if the business is to be ongoing and the capital base maintained through replacing assets as they wear out.

Investment Cost

Investment cost is the other major fixed cost that needs to be estimated to determine if the funds tied up in machinery assets are generating or will generate an adequate rate of return. A quick rule of thumb used to estimate this cost is to: (1) find the mid-point value of the machine over its lifetime, and (2) multiply this value times the investor's required rate of return to find the average annual investment cost. The steps in the calculation of this cost are as follows:

Step 1

$$\frac{\text{purchase price} + \text{salvage value}}{2} = \text{average annual value of machine over its lifetime}$$

Step 2

$$\text{average annual value of machine over life} \times \text{rate of investment return} = \text{investment cost}$$

Table 1

Annual Depreciation Using Two Methods of Calculation for a Machine Originally Costing $20,000 With a Salvage Value of $4,000 and an Expected Useful Life of 8 Years

Year	Straight Line Annual Depreciation	Declining Balance Annual Depreciation (Depreciate @ 20%)
1	2,000	4,000
2	2,000	3,200
3	2,000	2,560
4	2,000	2,048
5	2,000	1,638
6	2,000	1,311
7	2,000	1,049
8	2,000	194*
Total Depreciation	16,000	16,000

*Depreciate down to salvage value early in 8th year.

Application of the above to the situation illustrated in Table 1 results in the following cost:

$$\frac{20{,}000 + 4{,}000}{2} \times 11\% = \$1{,}320 \text{ per year.}$$

Capital to purchase farm machinery can come from either the farmer's own funds or can be borrowed. If it is borrowed there will be a contractual agreement to repay the capital plus a specified rate for the interest cost. If the farmer uses his own funds, they remain as equity in the business in the form of the purchased asset. This equity declines in value as the machine loses value through depreciation. The farmer should receive an adequate return on these equity funds as they could earn money in other investments. In planning for an investment the manager should charge a cost for capital that will pay the lender the interest rate agreed upon plus a required rate of return to the equity funds that he has invested. As returns from investment in machinery are generated throughout the years of life of the machine, a farmer's original output of capital does not stay tied up in the machine. A general way of estimating the farmer's equity in a machine is to base it on the year to year value as the machine depreciates down to its salvage value.

Table 2 illustrates the annual cost for investment funds tied up in the farm machine shown in Table 1. Note that it was originally purchased with $10,000 of the farmer's funds plus a $10,000 loan repayable with equal principal payments

over five years and 12 percent interest on outstanding balance. The farmer is requiring a 10 percent return on the equity investment.

Making this detailed calculation results in a total investment cost of $9,321 over the lifetime of the machine. If the financing had been for a longer time period, interest on the loan would have been greater but equity costs would be less. This detailed calculation gives a more accurate and somewhat lower total investment cost than the rule of thumb previously discussed if a rate of return of 11 percent was selected based on a mix between the cost of borrowed and owned capital. The rule of thumb approach would have taken the average machine value of $12,000 times 11 percent times the 8 years of ownership, giving a total of $10,560 as the lifetime investment cost of owning the machine.

Other Fixed Costs

Insurance and housing are the remaining fixed costs of machinery ownership. They come about upon purchase of the machine and do not change relative to use of the machine. If a machine is disposed of, insurance policies can be changed or cancelled but housing, once built or acquired, cannot easily be changed. **However, when making a machinery investment the manager should look at these costs using a marginal approach.** If existing machinery housing facilities can accommodate the added machinery, their cost is already taken care of by the business and should not be considered in the current decision. Similarly, if the machinery insurance policy provides blanket coverage and adding this machine does not affect the premium, this fixed cost is constant and should not affect the decision.

Variable Costs

Variable costs are defined as those that vary with production and are under control of the manager over the time period being considered. In regard to day to day operations these are the costs associated with inputs and services required to operate the machine. They are often called operating costs and are measured on a per unit of production (acre, head, etc.) basis.

Those costs most relevant to the machinery investment decision are fuel, lubrication, repairs, and labour requirements. They are important because some machines will use these inputs more efficiently than others. The efficiency may come from better technology or higher quality material that cuts energy waste and/or repair requirements. Other sources of this efficiency can be from the capacity to cover more area or units due to improved ground speed, handling ability or simply less down time for repairs and maintenance.

As total costs of operating a machine are dependent on the above sources of efficiency these variable costs need to be analyzed on both a productive unit (acre, cow) basis and output (tonne, kilogram) basis. In most cases the lower variable cost per productive unit is a good indicator by which to compare one machine with another. However, if one machine achieves a lower cost through inefficient performance of the particular task there may be an adverse effect on yield. The best measure to take into account in making a machinery investment decision is variable cost per unit of output. It means

Table 2

Detailed Calculation of Investment Cost Taking
12 Percent Interest As Cost of Debt Ownership and
10 Percent Rate of Return to Equity Ownership

Year	Machine Value	Loan Principal O/S	Interest on Loan @ 12%	Farmer's Equity	Return to Farmer Equity @ 10%
1	20,000	10,000	1,200	10,000	1,000
2	16,000	8,000	960	8,000	800
3	12,800	6,000	720	6,800	680
4	10,240	4,000	480	6,240	624
5	8,192	2,000	240	6,192	619
6	6,554	0	0	6,554	655
7	5,243	0	0	5,243	524
8	4,194	0	0	4,194	419
9	4,000 (salvage value)	0	0	4,000	400
Total Investment Cost			3,600		5,721

estimating yield expectations with each option. If the expectations are the same, the cost per acre or head is an adequate measurement. If some differences are expected it is worth while to try and estimate them.

Use of Cost Information

The traditional means of making a machinery decision is to estimate average fixed and variable costs on a per acre or productive unit basis. These costs are compared to the average advantage obtained through savings from costs of existing machines and/or improved output or revenues. This is a useful method called partial budgeting and has been used by successful farmers for years. To make estimates reflect the lifetime of a machine, the analysis bases fixed ownership costs on some average or mid point of the asset's value as it goes from new to some salvage value at the end of its useful life. Similarly variable costs should reflect those of an average aged machine rather than a new or worn out machine. Once this average total cost has been estimated the average advantages of this asset are calculated. A good rule of thumb has been to discount current output prices if the analysis is taking place when a commodity appears very profitable, and to adjust upward if the commodity is currently in a depressed state.

Recent developments and better access to computer hardware and software has made it possible to carry out farm investment analysis through capital budgeting. This method differs from partial budgeting as it estimates the costs and returns for each specific time period. It accounts for the fact that assets lose value each year and provides a means to allow returns and costs of operating machines to be affected by inflation, taxes or cyclical price trends. A method of capital budgeting for farm machinery is explained in detail later in this publication.

The decision making procedure and examples provided in further sections of this publication are set up to reflect all costs discussed in this section. The decision maker is required to provide estimates of how many productive units will be serviced by the machine and output expectations for those productive units. If they differ for the various options considered the cost component of the analysis will be accurately reflected to give the best possible estimate of return to machinery investment.

Alternative Means for Control of Machinery Services

Introduction

Farm managers require the use of a certain set of machinery operations or services throughout the year. Machinery services are performance of the actual task or tasks for which the particular machine is required. For example, a cultivator provides tillage services, while a combine provides harvesting services. Some machines (e.g., tractors) provide services in more than one task on the farm. Although there may be advantages to ownership of the actual machine, **the most important issue for farmers to consider is control or ownership of the services provided by the machine.**

From tillage to harvest, the farmer must control the services of the right machine at the right time. The most common form of control used by farmers is outright ownership of machinery. There are, however, several alternative forms of control that are available to farmers. These alternatives may be compared in terms of such factors as financial feasibility, costs incurred by the farmer and tax implications. Depending upon the circumstances, any one of the alternatives may be preferable to ownership.

Ownership

Ownership is the most common method of controlling machinery services. Through a combination of debt and equity financing, ownership of the actual asset is attained. The initial equity invested by the farmer generally consists of a piece of machinery to be traded in and/or a cash downpayment. The remainder of the purchase cost is usually financed by the machinery dealer or a lending institution. The loan may be repaid quickly or over a period of several years. Financing terms are usually set such that the outstanding

loan balance is always considerably less than the depreciated value of the machinery. If the machinery is purchased, the farmer acquires all rights and obligations associated with ownership, for as long as he/she owns it. The farmer is responsible for all costs, fixed and variable, cash and non-cash, associated with the ownership and operation of the particular piece of equipment.

Lease or Rental

Leasing is a second form of machinery control available to farmers. A lease is an agreement whereby the farmer, or lessee, acquires control of a piece of machinery from the machinery dealer, or lessor, for a set period of time. Basically, the farmer owns the services of the machine for the length of the lease.

Some leases are relatively short-term (i.e., several weeks or months). These are referred to as rentals or operating leases. Financial leases, which are longer in duration, may cover periods of time up to several years. Financial leases often provide an option for the farmer to purchase the equipment, at a set price, upon expiration of the lease. Otherwise, control of the machinery reverts to the lessor. These terms are all generally specified in a written leasing agreement. Also specified in the agreement are the periodic lease payments and the costs to be incurred by the farmer and the lessor. In general, the farmer does not incur all costs associated with ownership and operation of the machinery. For example, the costs associated with depreciation are not usually incurred by the farmer. The size of the lease payment will depend upon the terms specified in the agreement.

Custom Hire

This option involves the hiring of machine and operator services for a specific period of time and/or to perform a particular task. Custom hire generally involves arrangements that are of shorter duration than for outright ownership or leasing. The farmer controls the machinery services only long enough for the particular task to be completed. Another difference is that the use of custom hiring brings not only machinery services to the farm business, but also additional labour in the form of the machine operator's services. Very often the quality of this labour is quite high. In general, the only cost to the farmer is the explicit cash expense of hiring the machine and operator. The cost is agreed to by the farmer and the custom operator and is based on not only the fixed and variable costs associated with the machinery, but also on the value of operator labour.

Considerations in Choosing a Form of Control

There are several factors that must be considered when choosing a form of control for machinery services. In many instances, there may be a tradeoff involved. One alternative may have some advantages while other alternatives have different advantages. The following section briefly discusses some of these considerations.

Investment Requirements

An important consideration in decisions concerning farm machinery is the initial investment requirement. This initial investment is usually obtained from equity in the business. The equity may take the form of cash from savings or an

old piece of machinery being traded in, or a combination of the two. While not often considered as such, leasing and custom hiring represent forms of investing in farm machinery. The nature of these methods of controlling machinery differ from those associated with ownership, as noted above. All three forms of control should be evaluated as investments, however.

In general, the initial investment required to obtain ownership of machinery is greater than is required for leasing or custom hire. While debt financing may be used to cover much of the purchase cost, a significant downpayment is also required. In some cases, the size of the initial investment may make ownership financially infeasible. Leasing requires a much smaller initial investment from equity. There may be some costs or service charges that are paid initially, but there is nothing equivalent to the downpayment required for ownership. Custom hiring also does not require an initial investment from equity. The farmer has control of the machinery services for a short time and the only cost is the expense of hiring these services.

There are factors to consider in deciding what combination of cash and used equipment to utilize in making the initial equity investment. If the purchase is being made to replace an existing machine, the farmer may not wish to keep the present piece of machinery. The use of a trade-in also reduces the impact of the purchase on farm liquidity. If a significant portion of the initial investment is in the form of cash, the farm's liquidity is reduced as cash is more liquid than the asset being acquired with it. A final consideration is the value received for the trade-in. A fair market value may not be offered, or if a fair value is offered the new machine's purchase price may be higher as a result. In these instances, the farmer may be better off utilizing a higher cash downpayment and keeping the present machine.

Financial Feasibility

Machinery investment decisions must be examined as to their financial feasibility. This involves the ability of the farmer to generate sufficient cash to make the initial investment, as well as any principal and interest payments, lease payments, etc. If the investment itself does not generate sufficient funds, or if there is a time lag involved in generating these funds, the necessary cash must be obtained from other places. The purchase of a piece of machinery may be desirable, but if there are insufficient funds for a downpayment and/or any resulting loan payments, the investment is financially infeasible. The degree of debt financing required may place the farmer in a very risky solvency position, again making the investment financially infeasible. These problems are particularly important for new entrants to farming. These individuals may not have a sufficient equity base built up in the farm operation. Variability in income may result in the new entrant not being able to adequately and reliably service the required debt.

The potential for future liquidity problems also differs between forms of control. If a farmer purchases machinery, he/she is responsible for all future costs. In the event of an unexpected breakdown, for example, the farmer must bear the cost of repairs. With other forms of control for machinery services, the farmer may be protected from this occurrence. The potential risk of the investment is therefore reduced through the use of leasing or custom hire. This should also be

considered in analyzing the feasibility of the proposed machinery investment.

The question of feasibility is a major concern for decisions regarding ownership of machinery, which usually involve a downpayment as well as debt financing. It is also a concern for machinery leasing, particularly for financial leases which require a longer term fixed commitment by the farmer in terms of lease payments. In general, however, the cash flow and solvency implications of custom hiring and leasing are such that these forms of machinery control are less likely to be financially infeasible.

Expenses

As discussed earlier, there are numerous costs associated with owning and/or operating machinery. **The costs for which the farmer is responsible vary according to the form of control chosen.** In some cases, this may affect the preference for a particular form of control. If the machinery is owned by the farm manager, all variable costs (fuel, repairs, etc.) and all fixed costs (insurance, depreciation, etc.) are incurred by him/her. If a machine is custom hired, none of these costs are explicitly incurred by the farmer. The only expense is the custom rate charged by the machine operator. This rate, however, is based on the custom operator's costs of owning and operating the machinery.

The expenses associated with machinery leasing vary. This aspect of the leasing agreement is often negotiable. There is, of course, the periodic lease payment to be made. The farmer is also responsible for most variable costs such as fuel and lubrication. Expenses such as repairs and insurance may be paid by the farmer or the lessor, depending on the terms of the lease. Other fixed costs, such as depreciation, are usually the responsibility of the lessor. The size of the lease payment is determined, to a certain extent, by the proportion of costs being paid by the farmer. The lease payment will be greater if the farmer incurs fewer of the expenses associated with the machinery. The lease contract should explicitly specify the responsibilities of both parties with respect to expenses.

Implications for Accounting

Another consideration in the decision concerning machinery investment is the effect on the business' financial statements and financial position. All three methods of control affect the income statement (i.e., profitability) and the cash flow statement (i.e., liquidity). Lease payments as well as payments for custom hiring appear as cash expenses or outflows on both statements. All fixed and variable cash costs incurred by farmers who own or lease machinery affect both of these statements. Non-cash costs (e.g., depreciation) incurred by the owners of farm machinery also affect the income statement. The degree to which these statements are affected varies between the different forms of control, however. Profitability is determined by the magnitude of the costs relative to the income being generated. Liquidity is affected by the amount of cash flowing in and out of the business, as well as the timing of the cash flows. These factors will differ between the alternative forms of control due to the differences in magnitude of costs and/or cash flows associated with each.

The effects on the balance sheet (i.e., solvency) vary between the alternative forms of control. If the machinery services

are obtained through custom hire, there are no direct effects on solvency, as farm assets and liabilities are not altered. If machinery is purchased, there are corresponding increases in the assets and liabilities for the farm business. The degree of increase in assets and liabilities will depend on the size of the downpayment (used machinery and/or cash). The purchase of machinery may result in increased or decreased equity for the farm business. If the purchase improves profitability, equity will increase. As time passes, however, the machine depreciates in value resulting in reduced asset values and, in some cases, reduced equity.

Operating leases or short-term rental agreements do not affect the balance sheet as the lease payments and any other expenses do not alter asset or liability values. Financial leases, however, may affect solvency if they meet certain requirements. In such cases, the long-term lease may be considered a fixed financial commitment, similar to a loan, and the periodic lease payments should be included as liabilities on the balance sheet. A corresponding addition should be made to farm assets, reflecting the value of the leased machinery to the farmer (usually the value of the remaining lease payments). To be incorporated into the balance sheet, the lease must meet one of three requirements. These requirements are (1) there is a reasonable chance that the farmer will purchase the machine when the lease expires, (2) the lease period is long enough that the farmer will receive virtually all of the services available from the particular machine, and (3) the lessor, as a result of the agreement, recovers his/her investment and earns a return on his/her equity.

Including the financial lease on the balance sheet does not add equity to the farm business. It does reflect the fixed financial commitment made by the farmer, however. Solvency measures such as debt/asset and leverage (debt/equity) ratios are affected as well. The fixed financial commitments associated with financial leases will result in increased values for both ratios.

Tax Implications

The form of machinery control chosen by a farmer has implications with respect to income tax calculations. If machinery services are custom hired, the cost of hiring the machine and operator may be claimed as a farm expense. If machinery is owned or leased, any cash expenses, such as fuel, repairs, insurance, etc., incurred by the farmer may be deducted in the calculation of taxable income.

There are differences between the alternative forms of control. Capital Cost Allowance (CCA) may be deducted from taxable income each year if the machinery is owned by the farmer. CCA is the method by which the original cost of an asset is allocated, for tax purposes, over a number of years. As such, the calculation and use of CCA is different from economic depreciation, discussed earlier. There is some flexibility in the amount of CCA that may be claimed each year. The farmer may, within certain limits, increase or decrease the rate at which CCA is calculated, in order to adjust taxable income. In most cases, CCA may not be claimed by a farmer if he/she leases machinery.

If machinery is leased, the entire lease payment may usually be claimed as a farm expense for tax purposes. The only exception is for leasing arrangements that contain an option to purchase clause. In

these cases, only a portion of the lease payment may be claimed. Only the interest portion of loan payments for purchased machinery may be claimed as an expense. In both cases, these expenses must be claimed in the year incurred.

There is a tradeoff in terms of tax considerations. The farmer must consider his/her level of taxable income, and resulting marginal tax rate, when evaluating the tax benefits for each form of control. The marginal tax rate is the amount of taxes (federal and provincial) payable on the last dollar of taxable income. The marginal tax rate increases as taxable income increases.

The tax benefits from claiming additional CCA or allowable machinery expenses will depend upon the marginal tax rate. For example, in 1988 a Manitoba farmer with taxable income of $5,000 faced a marginal tax rate of approximately 29 percent. A farmer with taxable income equal to $30,000 faced a marginal rate of approximately 42 percent. For every dollar of additional CCA claimed, the tax savings will be $0.29 in the first case and $0.42 in the second. The attractiveness of CCA deductions associated with ownership may therefore be reduced if taxable income is low. In these instances, however, the ability of machinery leasing to reduce taxes through deduction of lease payments is also reduced.

Flexibility, Timeliness, Availability and Reliability

These four terms are all important, non-quantifiable factors that should be considered in making machinery investment decisions. Flexibility concerns the amount of farm capital tied up in the machinery investment and the ease with which changes in the machinery complement may be made. Custom hire and short-term leasing provide the greatest flexibility. Both are short-term arrangements and may be changed very quickly, if required. As well, the fixed financial commitment is usually smaller than for the other two alternatives.

Financial leases and ownership provide less flexibility, as both involve long-term contractual arrangements that are more complicated to alter. Both of these involve fixed financial commitments (i.e., lease or loan payments). Ownership also involves a significant capital investment requirement.

Timeliness, availability and reliability are also important considerations with respect to machinery investment decisions. The terms refer to the farm manager's ability to perform machinery operations at the right time with a reasonable degree of reliability or quality. If a farmer controls machinery services through ownership or financial leasing, these considerations may not be of concern. As long as sufficient labour is available, tasks may be completed in a timely manner. As well, the reliability of the machinery will not be a problem if the equipment is properly maintained by the farmer.

Machinery services controlled through operating leases or custom hire may result in problems in these areas. The use of certain machinery services may not be available through one or both of these options. Alternatively, machinery services may not be available when required by the farmer. The reliability of machinery services obtained through custom hire or operating leases may also be in question. The farmer may have little knowledge or control over the previous care or present

condition of the hired or leased machinery. With custom hiring there may be an additional concern with the overall quality of services provided, as the tasks are not performed by the farmer.

Evaluation Procedures

There are several factors that should be considered and evaluated when making machinery investment decisions. These factors, as discussed earlier, include investment requirements, expenses, tax implications, etc. There are several evaluation procedures that have been developed for use as aids in the decision making process. The discussion in this section focuses on capital budgeting, which is one of the alternatives available.

Capital budgeting, as the name would suggest, is a budgeting procedure used to evaluate capital investments that involve costs and returns over a period of time. Capital budgeting is based on the assumption that money has a time value. In other words, a dollar received today is worth more than a dollar received at some future point in time. This time value concept may be justified in several ways. The most obvious justification is that a dollar received today may be invested and the investment will be worth more than a dollar in the future. Other reasons given for the time value of money include future inflation and uncertainty concerning the dollar to be received in the future.

When evaluating future sums of money, a discounting procedure must be used to calculate the present value of the cash to be received or paid. The procedure uses a discounting rate equal to the rate of return that could be earned on the money if it were available now. For example, if a farmer is to receive $100 four years from now, and could earn a 5 percent compounded return on the money if available now, the present value of the future sum is $82.27. In other words, the farmer could invest $82.27 now and have $100 in four years, given the 5 percent annual return. The rate at which future sums are discounted should represent the best alternative rate of return available to the farmer for his/her capital. This is also referred to as the opportunity cost of the farmer's capital; that is, the cost of losing the opportunity to invest the capital elsewhere.

There are a number of capital budgeting procedures available to evaluate and compare alternative investments. The most useful of these involves the calculation of the **Net Present Value (NPV)** for each alternative.

The NPV for a particular investment is calculated as follows:

$$NPV = -INV + P_1(1+i)^1 + P_2(1+i)^2 + \ldots + P_N(1+i)^N + SV(1+i)^N$$

where,

INV	=	initial equity invested
$P_1 \ldots P_N$	=	net cash flow associated with the investment in each year
SV	=	salvage value of the investment at the end of its useful life
N	=	the investment's useful life
i	=	discount rate or opportunity cost of capital

In other words, the annual net cash flows and salvage value associated with the investment are each discounted to a present

value, summed, and compared to the initial equity invested by the farmer.

In using capital budgeting to evaluate machinery investments, several pieces of information must be estimated, as indicated by the NPV formula. The annual net cash flows associated with the investment ($P_1 ... P_N$) must be estimated. These include any cash outflows or inflows such as loan or lease payments, cash operating receipts, taxes, repairs, insurance, etc. The initial equity investment (INV) is the cash downpayment, if any, made by the farmer from his/her equity. The salvage value (SV) is the value of the machine at the end of its useful life (N), net of any debt still owed for it. Finally, the discount rate (i) must be specified and should reflect the best alternative use of the farmer's equity, if it were not invested in the particular machine.

The NPV for a particular investment is a measure of its profitability. If the NPV is positive, the investment is profitable, given the discount rate. In other words, the rate of return earned by placing equity in the investment is greater than the required rate of return specified by the discount rate. The relative profitability of alternative investments may be evaluated by comparing NPV's. If comparing two or more alternative investments, they all must have the same time horizon. The investment with the greatest NPV is the most profitable.

Capital budgeting may be used to evaluate a variety of machinery decisions. These include:

1. leasing versus purchasing versus custom hire;
2. alternative financing arrangements; and
3. machinery replacement decisions.

The use of NPV requires estimates of only those revenues and expenses that are affected by the investment. In the case of many machinery investment decisions, the alternatives being evaluated differ only with respect to costs rather than revenues. For example, the difference between purchasing and leasing a machine is largely due to the difference in costs. In these instances, all revenues or expenses that are common to all of the alternatives being evaluated may be ignored. This would include cash expenses such as repairs and insurance if the actual amounts for each do not differ between alternatives.

The following example serves to demonstrate the usefulness of NPV analysis for machinery investment decisions. Suppose a farmer has decided to acquire the services of a 250 h.p. four-wheel drive tractor, through purchase or the use of a long-term financial lease. In either case, the effects of the acquisition on variable costs (fuel, repairs, etc.), insurance, as well as output levels and efficiency are the same for both options. These factors may be ignored in the evaluation procedure. The two alternative investments (purchase versus lease) differ in their impacts on cash outflows for principal and interest payments versus lease payments. They also differ in their effect on income taxes, as CCA and interest payments may be deducted from taxable income if the tractor is purchased. Lease payments may be deducted if the tractor is leased.

The purchase option involves purchasing the tractor now for $105,000. The tractor is kept and used for the next eight years, after which it is sold, for a salvage value of $30,000. A $15,000 downpayment is made from equity and the

remaining $90,000 is financed with a loan repaid over six years. The loan is amortized at a 12 percent annual interest rate, and annual payments of principal and interest are $21,890.31. Capital Cost Allowance for the particular asset class is calculated using a 20 percent rate.

The lease option involves a long-term lease agreement over an eight year period. At the end of eight years, the tractor is returned to its owner. Annual lease payments are $18,000.

Table 3 presents the NPV calculations for each option. The cash flows considered for the purchase option are loan principal and interest, and tax savings (i.e., tax reductions due to increased interest and CCA). The initial downpayment and salvage value are also included, if appropriate. Capital Cost Allowance is not a cash expense, and is therefore not included in the net cash flow for each year. It is required, however, to calculate tax savings. In accordance with tax regulations, only one-half of the normal CCA is taken in year one, and no CCA is taken in year eight as it is assumed that the tractor is sold. The only cash flows considered for the lease option are lease payments and tax savings (i.e., tax reductions due to increased lease payments). There is no initial equity downpayment and no salvage value.

For both options, the marginal tax rate is assumed to be 29 percent (i.e., for every $1 increase/reduction in taxable income, provincial and federal income taxes are increased/reduced $0.29). The discount rate used in the NPV calculations is 10 percent; that is, the best alternative use of the farmer's equity would earn him/her a 10 percent annual return.

As Table 3 demonstrates, the cash flows associated with each option, including any salvage value, are summed to an annual value and then discounted to a present value. These are then summed and the initial equity investment is subtracted to obtain a net present value. In this example, the NPV for the purchase option is -$70,135.06 and the NPV for the lease option is -$68,180.34. Since leasing provides the greatest (i.e., least negative) NPV, it is a more profitable alternative than purchasing the tractor.

In some cases, the farmer may be concerned about future inflation as well as uncertainty in future cash flows related to the investment. Net present value analysis can incorporate farmer expectations concerning inflation and/or risk. This is done by increasing the discount rate. For example, if the farmer can earn a 7 percent return on his/her equity now and expects the general price level to increase at approximately 4 percent annually (i.e., 4 percent inflation), the appropriate discount rate to use in NPV analysis is approximately 11 percent. Similarly, if future cash flows are uncertain, the discount rate may be increased (e.g., from 7 percent to 9 percent), reflecting a premium for risk. This results in less importance being placed on uncertain future cash flows as they are more heavily discounted. This also essentially increases the level of profitability required for the potential investment to be acceptable.

The NPV approach is not without shortcomings. Although more accurate than other procedures, NPV is also more complex to calculate as the procedure requires a great deal of information, including net cash flows over the life of the investment and a discount rate, representative of the producer's opportunity

Table 3

Capital Budgeting Example: Purchase Versus Leasing of a New Tractor

Year	Initial Downpay.	Loan Principal	Loan Interest	CCA	Tax[a] Savings	Salvage Value	Net[b] Cashflow	Discounted[c] Cashflow
Purchase Option: NPV = -70,135.06								
Present	15,000	0	0	0	0	0	-15,000	-15,000
1	0	11,090.31	10,800	10,500	6,177	0	-15,713.31	-14,284.83
2	0	12,421.15	9,536.16	18,900	8,227.06	0	-13,663.25	-11,291.94
3	0	13,911.69	7,978.62	15,120	6,698.6	0	-15,191.71	-11,413.76
4	0	15,581.09	6,309.22	12,096	5,337.51	0	-16,552.8	-11,305.79
5	0	17,450.82	4,439.49	9,676.8	4,093.72	0	-17,796.59	-11,050.28
6	0	19,544.92	2,345.39	7,741.44	2,925.18	0	-18,965.13	-10,705.32
7	0	0	0	6,193.15	1,796.01	0	1,796.01	921.64
8	0	0	0	0	0	30,000	30,000	13,995.22

Year	Lease Payment	Tax[a] Savings	Net[b] Cashflow	Discounted[c] Cashflow
Lease Option: NPV = -68,180.34				
Present	0	0	0	0
1	18,000	5,220	-12,780	-11,618.18
2	18,000	5,220	-12,780	-10,561.98
3	18,000	5,220	-12,780	-9,601.80
4	18,000	5,220	-12,780	-8,728.91
5	18,000	5,220	-12,780	-7,935.37
6	18,000	5,220	-12,780	-7,213.98
7	18,000	5,220	-12,780	-6,558.16
8	18,000	5,220	-12,780	-5,961.96

[a]Tax Savings are equal to 0.29 x (Loan Interest + CCA) for the Purchase Option and 0.29 x (Lease Payment) for the Lease Option.
[b]Net Cash Flow is equal to (Salvage Value + Tax Savings - Loan Principal - Loan Interest - Initial Downpayment) for the Purchase Option, and (Tax Savings - Lease Payment) for the Lease Option.
[c]Discounted Cash Flow is equal to Net Cash Flow x $(1.10)^n$ for both options, where n is the year.

cost for equity. These are often difficult quantities to estimate. In general, however, the use of NPV to evaluate investments is superior to other methods available. The other budgeting procedures that are often used consider only present costs and returns, or averages over the life of the investment. These procedures ignore the time value of money.

Evaluation of investments using NPV as the criterion allows the farmer to choose the most profitable alternative. It does not, however, guarantee that the investment is financially feasible. In other words, the investment may seem profitable and yet the farmer may not be able to implement it. There may be several time periods in which the projected net cash flows associated with the investment are negative (e.g., the example in Table 3). The deficits would have to be made up with surplus cash from some other part of the farm's operation. As well, the farmer must have enough equity to make any downpayment that may be required. Thus, the evaluation of alternative investments is a two-step process. The most profitable alternative is selected using NPV analysis. The financial feasibility of this alternative is evaluated in order to determine if it may be implemented. If not, the investment should be adjusted in order to make it more feasible. This may involve using more or less equity capital or borrowed capital. If the plan is still infeasible, it is eliminated from consideration and other alternatives are examined.

Other Issues in Machinery Decisions

Machinery Versus Labour

Machinery and labour are both important inputs in agricultural production. To a certain extent, they are substitutes but it would be expensive for a farmer to attempt to completely eliminate the use of one or the other in the farm's production activities. In other words, a combination of both inputs is required.

The traditional trend in agriculture has been to substitute capital inputs (e.g., machinery) for labour. Evidence of this trend is presented in Table 4. While the amount of improved farmland in Manitoba has been growing over time, the labour force available to farm it, as represented by total farm population, has been decreasing. This labour has been replaced, for the most part, by machinery, as demonstrated by the increase in machinery investment. This trend has slowed somewhat in recent years but is still present. Larger and more efficient machinery results in displacement of labour. There are several reasons for this trend. Farmers desire more leisure time. Larger machinery and less labour may be a more efficient and less costly system than more labour intensive practices. Farmers have also achieved, in some cases, larger volumes of output and economies of size through investment in more efficient and higher capacity equipment, tied with expansion of the farm as a whole (e.g., more acreage).

In making machinery decisions, a farmer must consider the amount of labour that will be required and/or available to perform a certain task. Labour is of no value to a farm operation if it is not

Table 4

Manitoba Agriculture Trends:
Improved Land, Farm Population and Machinery Investment

Year	Improved Land (000's of Hectares)	Farm Population	Machinery and Equipment Investment (Million Dollars)
1941	3,978	249,599	59
1946	3,955	224,919	94
1951	4,355	219,233	232
1956	4,635	202,163	244
1962	4,842	172,946	272
1966	5,037	161,662	380
1971	5,181	131,202	412
1976	5,217	114,115	960
1981	5,504	98,375	1,823
1986	5,403	86,505	2,231

Source: Statistics Canada, Census Division.

available when needed. The timeliness of labour availability is therefore very important.

On the other hand, if the farmer is considering the acquisition of larger machinery, the issue of displaced labour should be considered. What is the value of the labour being replaced, in terms of its alternative use? This question is important, regardless of whether it is the farmer's labour, family members' labour, or hired labour that is being considered. If it is hired labour being replaced, the labour has an explicit value equal to the wage rate or salary being paid. The value of operator or family labour being replaced is not as obvious, however. The value depends upon the purpose for which the available labour will be used. If the displaced labour has a reasonable alternative use (e.g., off-farm employment) or if labour is a constraining factor (i.e., would have to hire labour otherwise), then the increase in machinery size may be justified. If labour is not a constraining factor or if the displaced labour does not have an alternative use, the farmer must consider whether the increase in machinery size and corresponding decrease in labour requirements is warranted.

Another issue concerns the quality of labour being replaced. If significant labour is required for machinery operations, some of it may be hired. The quality of hired labour may be extremely variable. As a result, the farmer may conclude that it is worth the extra cost of increasing the size of machinery in order to decrease the amount of hired labour that is required. This may result in decreased variability with respect to the quality of work.

Estimating Field Capacity

An important consideration in machinery investment decisions is the field capacity of the equipment to be acquired. **In particular, how much work may be completed by this equipment in a given amount of time?** If time is not a constraint, a given task or operation may be performed by equipment of any size. In general, however, time is a constraining factor. The farm manager has a limited amount of time to complete a certain task. It is therefore important to know the field capacity for the machinery being considered.

The field capacity is usually expressed in terms of hectares or acres per hour. It is determined, for a given piece of machinery, by the ground speed, width, and field efficiency of the machine. Field capacity is calculated as follows:

$$Hectares/hour = \frac{(S \times W \times E)}{10}$$

where,

S = ground speed in km/hr
W = width of the machine in metres
E = field efficiency of the machine

If field capacity is desired in terms of acres per hour, the calculation is the same with speed expressed in miles per hour, machine width in feet and the expression is divided by 8.25 instead of 10.

The field efficiency of a particular machine reflects the efficiency with which field time is utilized when operating the machine, and depends on a number of factors. Stoppages for repairs and/or maintenance result in lost time. For tillage equipment, there is time lost due to turning and overlapping. When seeding equipment is used, there is lost time due to stoppages to refill hoppers, etc. Similar examples may be found for other types of farm machinery. No piece of equipment is 100 percent efficient and the field efficiency index reflects this. Table 5 provides typical ranges of field efficiency values for various categories of machinery. The actual field efficiency for a given piece of machinery will vary, of course, due to individual field practices.

To show how this field capacity information may be used, consider a farmer who has 320 hectares of tillable cropland. He/she is considering the purchase of a seed drill that is approximately eight metres wide. The ground speed of the drill is approximately 8 km/hr. The field efficiency for this type of equipment is approximately 75 percent. The field capacity for this drill is (8 x 8 x 0.75)/10 = 4.8 ha/hr. It will therefore require approximately 67 hours for the farmer to seed the 320 hectares using this particular drill.

Selection and Sizing

An important part of the machinery investment decision is the selection of a particular size of machine. This decision is affected by several factors, some of which have been discussed previously. Acquisition of larger machinery has several advantages associated with it. Larger machines will usually result in more timely completion of tasks. This is important as time is often a limiting factor in field operations. Larger machinery also results in less labour being required to perform given tasks. Larger machinery may also result in greater efficiency in terms of variable costs (i.e., fuel, repairs, etc.) per unit of output. Finally, if future expansion is planned, larger machinery may

Table 5

Typical Machinery Field Efficiency Values

Machine	Field Efficiency Range
Tillage Implements	70% - 90%
Grain Drills	65% - 85%
Fertilizer and Chemical Application	60% - 75%
Balers	70% - 90%
Swathers	75% - 85%
Combines	65% - 85%

Source: American Society of Agricultural Engineers, Agricultural Machinery Management Data.

be desired in anticipation of greater demands being made of the farm's machinery set.

There are, of course, disadvantages to acquiring larger machinery. The investment requirements associated with acquiring the services of larger machinery are greater. The ownership costs associated with controlling the services of larger machinery (i.e., depreciation, investment costs, etc.) are greater than for smaller machinery. The value of labour displaced by the larger machinery must also be considered. If this labour has little value in terms of alternative use, the benefits of controlling the services of larger machinery are reduced.

To determine the size of machine required to perform a certain task, several pieces of information are required. These include the size of the task (e.g., hectares being cultivated), and the time available to complete the task. The time available to complete the field operation in question will depend upon expected weather conditions as well as labour availability. Average or minimum lengths of time are both appropriate to use as an estimate.

If these two pieces of information are known, the farmer can determine the required field capacity for the machine being considered. The field capacity for any given piece of machinery can be estimated, given its width, ground speed and field efficiency. This can be compared to the required field capacity to determine if the machine is of sufficient size. The required field capacity can also be used to determine the minimum size of machine required to complete the field task in the available time.

To demonstrate how this information is generated and used, suppose that a farmer has 400 hectares of cropland to harvest. He/she is considering the purchase of a new combine. The farmer estimates that the harvesting must be completed in 14 days, and 10 hours of labour per day are available for combining during that period. A total of 140 hours of labour are available

to harvest 400 hectares. The field capacity of the new combine must therefore be at least 2.86 ha/hour (400 hectares divided by 140 hours).

The farmer has narrowed his/her choice to two combines. The first is approximately 6 metres wide, while the second is approximately 4.5 metres wide. Both combines have a ground speed of 7 km/hour. Using the formula for field capacity introduced in the previous section (assuming 75 percent field efficiency), the field capacity of the first combine is (7 x 6 x 0.75)/10 = 3.15 ha/hour. The field capacity of the second combine is (7 x 4.5 x 0.75)/10 = 2.36 ha/hour. Since the required field capacity is 2.86 ha/hour, only the larger combine has sufficient capacity to ensure that the field operation will be completed in the available time.

One other consideration in the sizing decision concerns the mix of machinery already present on the farm. For example, the size of tractors available on the farm is important in deciding upon the size of pull-type equipment to acquire. If the size of machine required or desired is not in line with the rest of the machinery complement, the farmer must either re-evaluate his/her machinery decision or consider other machinery acquisitions to accommodate the larger machinery. In addition, if the machine being acquired is a tractor, the horsepower requirements of all machinery to be drawn must be considered. If the horsepower requirements are a limiting factor, a larger tractor may be needed.

Machinery Sharing or Machinery Syndicates

As discussed in earlier sections, acquisition and control of machinery services involve an initial investment, along with the costs of owning and operating the machinery services. **One alternative to sole control or ownership is machinery sharing.** This involves some type of arrangement whereby two or more farmers form a syndicate and share the costs and services of farm machinery.

There are several advantages to a syndicate arrangement. The individual farmer's investment requirement is reduced as the cost of purchasing or leasing is spread among the individuals involved in the syndicate. Such an arrangement may make an otherwise infeasible machinery purchase feasible. Individuals in the syndicate also share the costs of owning and/or operating the machinery services. Depreciation, repairs and maintenance, etc. are all shared. This results in lower machinery costs for each individual, relative to the situation where each one has sole control of the machinery services. A sharing agreement is especially useful for parent-son or parent-daughter arrangements where the son or daughter is a new entrant to farming. If a sharing arrangement is not considered, the new entrant may have difficulty obtaining adequate machinery services, given his/her financial situation.

There are also potential disadvantages associated with machinery syndicates. One disadvantage concerns the availability of machinery services when needed. For example, if a combine is being shared and time is a limiting factor for harvesting, there may be disputes over which partner gets priority in its use. There may also be disputes concerning liability for repairs or maintenance costs if some members of the syndicate are perceived to be negligent in the care of the machinery. Finally, there is the possibility that disputes or other factors may result in one or more syndicate members deciding to pull out of the agreement. This may cause

problems for the remaining members in terms of meeting ownership and operating costs.

In setting up a machinery sharing arrangement, there are several factors or issues to be considered. There should be a written agreement, signed by all parties, specifying all the details of the arrangement. In particular, the share of investment requirements to be paid by each member of the syndicate should be stated. As well, each member's share of ownership and operating costs should be clearly specified. The division of costs may be determined in a number of ways, but generally depends on the share of use by each member. Provisions should be made to determine priority of use, if a dispute of this sort should arise. The eventual disposal of the machinery should also be provided for, specifying the share of the salvage value to go to each syndicate member. Finally, provisions should be made for changes in the arrangement. This may include changing the share of costs, or even the possibility of one or more members leaving the syndicate. If these issues are dealt with in a written agreement, unpleasant surprises may be avoided.

Another form of machinery sharing may be achieved through the formation of a machinery co-operative. A co-operative differs from the syndicate arrangement in that the co-op is a separate entity, incorporated by two or more farmers. The co-op, rather than the farmers, owns the machinery. The co-op members share in all of the machinery costs, as well as the Capital Cost Allowance. A machinery co-operative has most of the advantages and disadvantages associated with the less formal machinery syndicate discussed earlier. There are also other advantages and disadvantages that are unique to co-operatives. These are discussed, in some detail, in publications concerning farm business arrangements.

Machinery Replacement

An important decision with respect to farm machinery is when to replace a particular piece of equipment. Should it be replaced this year, next year or five years from now? There are several factors that should be considered in making this decision. These include the costs of repairing and maintaining the present machine, obsolescence of the present machine, and tax implications. In some cases, the farmer may want to replace his/her present machine simply because of a desire to have newer machinery.

One of the most important considerations in the decision to replace a piece of machinery is the condition of the present machine. Regardless of the care taken by a farmer in maintaining machinery, parts wear out. This leads to increased maintenance and repair costs as the machine ages. For example, studies by agricultural engineers indicate that of the total repair costs for a two-wheel drive tractor, approximately 12.5 percent occur during the first quarter of its useful life, 23 percent during the second quarter, 30 percent during the third quarter and 35 percent during the final quarter. This pattern is shown in Table 6. Table 6 also provides machinery repair information for other types of machinery, which display similar patterns. Thus, increasing repair costs are an incentive for machinery replacement.

A related consideration is the reliability and efficiency of the present machine. Increasing maintenance and repair costs result in decreasing reliability.

Machinery Repair Cost Information

Machine	Estimated Wear-Out Life (Hours)	Repairs As % of List Price	% of Total Repairs Incurred During Each Quarter of Useful Life			
			First 1/4	Second 1/4	Third 1/4	Fourth 1/4
4WD Tractor	12,000	100	12.5	22.9	29.6	35.0
2WD Tractor	12,000	120	12.5	22.8	29.6	35.1
SP Combine	2,000	60	14.5	23.8	29.2	32.5
Farm Truck	20,000	80	14.4	23.6	29.0	33.0
Baler	2,500	80	14.4	23.6	29.0	33.0
SP Swather	2,500	100	14.4	23.6	29.1	32.9
Fertilizer Equipment	1,200	120	14.4	23.7	29.0	32.9
Seeding Equipment	1,200	100	14.4	23.7	29.0	32.9
Tillage Equipment	2,500	120	16.5	24.1	28.1	31.3

Source: American Society of Agricultural Engineers, Agricultural Machinery Management Data

This can adversely affect the timeliness with which field operations are completed. As well, the efficiency with which the machinery performs the required field operations may be affected. This may involve effects on the quality of the completed task. It may also result in decreased economic efficiency (e.g., fuel consumption) for the field operation. All of these are potential reasons for the replacement of the present machine.

There are other incentives that may result in machinery replacement before increasing costs or decreasing reliability become a factor. One of these is changing technology. Equipment manufacturers are constantly upgrading and improving their machinery lines. This often results in larger and more efficient farm machinery becoming available. The farmer's machinery becomes somewhat obsolete. There is therefore incentive to replace machinery in order to take advantage of improved technology.

Expansion of the farm operation or changes in enterprise mix may also be an incentive for machinery replacement. Expansion of crop enterprises may result in the present machinery set being too small to complete all field operations in a timely and efficient manner. The farmer should then determine the size of machinery required using the procedures outlined previously. Changes in the crop enterprise mix may result in different types of machinery being required. For example, the replacement of cereal grains with forages will render some present machinery unnecessary and require the acquisition of different machinery services.

There are also tax implications and, in some cases, tax advantages associated with machinery replacement. Machinery purchases are often made at the end of the calendar or fiscal year in order to reduce taxable income. The merits of this reasoning depend on several factors. The financial feasibility of the purchase should be considered. Any tax advantages may be outweighed by a weakened solvency or liquidity position. Short-term benefits may be outweighed by future hardships or problems. The anticipated level of future taxable income should also be considered. The advantage in terms of reducing taxable income should be significant if tax reduction is the only justification for the purchase.

The ability of machinery replacement to reduce taxable income depends upon the cost of the new machine and the proceeds received from the sale of the present machine. Machinery purchases reduce taxable income through increased Capital Cost Allowance (CCA), which is deducted from taxable income. If a piece of machinery is replaced, CCA may be taken on one-half of the difference between the purchase price of the new machine and the proceeds from disposal of the present machine, if that difference is positive. If the proceeds from the sale of the present machine exceed the original capital cost of the asset, the difference between the proceeds received and the original capital cost is considered to be capital gain. In this case the amount subtracted from the purchase price of the new machine, for CCA calculations, is the original capital cost of the present machine.

The tax advantages of a machinery purchase are therefore decreased by the effects of the proceeds received for the machine being replaced. The proceeds must be subtracted before CCA is calculated, and then only one-half of the difference can be used in the CCA calculation during the first year. The full amount may be used in subsequent years.

Depending upon the individual farmer's situation, and the machinery being bought and sold, capital gains, recapture of CCA or terminal losses may have to be considered in the net tax effects of the replacement decision. These issues are dealt with in more detail in income tax guides and publications.

The decision when to replace a piece of machinery may be done using one of several budgeting methods. The approach suggested here is to use a capital budgeting framework; that is, the use of net present value (NPV) analysis. This method, as outlined earlier, takes into account the time value of money and the net cash flows over several time periods in order to evaluate alternative investments. In this case the alternative investments are (1) keeping the present machine, and (2) trading it in for a new machine. The net cash flows include all cash inflows and outflows relevant to the investment. The initial equity investment, as well as ending equity in the investment are also included. The initial equity investment should include only the net cash outflow associated with the machinery investment (i.e., the cash down payment). The rate used to discount the cash flows should represent the opportunity cost for the farmer's equity.

There are several factors to consider in the NPV analysis of alternative machinery replacement strategies. The pattern of expenses for repairs and maintenance must be considered for old and new machinery, as well as the effects of any differences in efficiency of field operations (i.e., fuel consumption, harvest losses, etc.). Other machinery costs that may differ between old and new machinery must be included (e.g., insurance premiums). The salvage value of the present machine must be considered, as well as any changes in that value over time (e.g., salvage value now versus four years from now). Also required for the analysis are the initial equity invested in the new machine, any lease or loan payments that are to be made, and an estimate of the net salvage value for the new machine at the end of the time period being considered.

The impacts on taxes must also be incorporated into the analysis. The effects of changes in CCA, potential capital gains, recapture of CCA and/or terminal losses are accounted for through income tax calculations. As long as the time horizon for all replacement alternatives is the same (e.g., replace in six years versus replacement now and keep new machine for six years), the NPV of each alternative may be compared directly. The alternative with the greatest NPV is the most profitable strategy.

The following example demonstrates the use of capital budgeting in machinery replacement decision analysis. Assume that a farmer is considering the possibility of replacing a 250 h.p. 4WD tractor. The present machine is eight years old and has 4000 hours of use. The farmer is considering two options; replace the machine now and keep the new machine for eight years, or replace the tractor two years from now and keep the new machine for six years.

If the farmer assumes that the efficiency with which either tractor (new or used) performs its tasks is equal, the revenue side of the analysis may be ignored. Only the initial equity investment, the salvage value, and cash expenses need to be considered. Whether the farmer replaces the tractor now or later, the purchase is to be financed with a six year amortized loan and a 12 percent interest rate. The machine being traded in is to be used as the downpayment. The present

market value is $30,000. The farmer estimates that it will be worth $25,000 in two years. If the tractor is replaced now or later, the replacement will cost $105,000. The new machine will have a market value of $40,000 and $30,000 at six and eight years of age, respectively.

The old and new machine differ in the annual repair costs. Assume that all repairs, excluding normal maintenance, are covered by warranty for the first two years of operation. Capital Cost Allowance is calculated at 20 percent annually for both old and new machines. The marginal tax rate, as defined earlier, is 29 percent.

Table 7 presents the calculations for the NPV analysis. Because the only equity invested for each option is the old machine (i.e., no cash downpayment), there is no initial equity investment to be considered in the analysis. The net cash flows take into account differences in amounts and timing of repairs, loan payments and Capital Cost Allowance, as well as their effects on income taxes. As Table 7 indicates, it is more profitable to replace the tractor two years from now (i.e. NPV = -$41,310) rather than replacing it now (NPV = -$52,667). Alternative replacement strategies may be compared to these two in a similar manner.

New Versus Used Equipment

An option often considered by farmers when making machinery decisions is the purchase of used machinery. There are several factors to consider when examining this option. As is the case with all machinery decisions, there are positive and negative aspects associated with this alternative.

The most obvious difference between acquiring new and used machinery is the lower investment requirement for used machinery. The purchase of used machinery is therefore more likely to be financially feasible. Farmers may be able to afford to buy a used machine when an equivalent new machine is too expensive.

The lower investment requirement associated with used machinery is of particular importance for new entrants to farming. These farmers typically have limited equity to utilize in making machinery investments. As a result, the lower purchase price of used equipment allows a new entrant to acquire or control more of the machinery services required to operate his/her farm.

Another positive aspect of used equipment is that some of the fixed costs associated with owning the machine are less than for an equivalent new machine. For example, because of the lower purchase price, annual depreciation and investment costs are lower than for new machinery. This has a positive effect on farm profitability.

There are, however, several disadvantages associated with used machinery. The most obvious one is increased operating expenses, relative to new machinery. As mentioned earlier machinery maintenance and repair costs increase with age, while the efficiency and reliability of machinery may deteriorate. All of these factors may affect the timeliness with which field operations are completed.

The lower purchase price associated with used machinery has negative implications for tax management. A lower purchase price results in reduced potential for income tax reduction through Capital

Table 7

Capital Budgeting Example: Alternative Machinery Replacement Strategies

Year	Loan Principal	Loan Interest	Repairs	CCA	Tax[a] Savings	Salvage Value	Net[b] Cashflow	Discounted[c] Cashflow
Replace Now: NPV = -52,667								
Present	0	0	0	0	0	0	0	0
1	9,242	9,000	100	7,500	4,814	0	-13,528	-12,298
2	10,351	7,891	200	13,500	6,261	0	-12,181	-10,067
3	11,593	6,649	2,100	10,800	5,669	0	-14,673	-11,024
4	12,984	5,258	2,520	8,640	4,761	0	-16,001	-10,929
5	14,542	3,700	2,835	6,912	3,900	0	-17,177	-10,666
6	16,288	1,954	3,140	5,530	3,084	0	-18,308	-10,334
7	0	0	3,500	4,424	2,298	0	-1,202	-617
8	0	0	3,640	3,539	2,082	30,000	28,442	13,268

Year	Loan Principal	Loan Interest	Repairs	CCA	Tax[a] Savings	Salvage Value	Net[b] Cashflow	Discounted[c] Cashflow
Replace in Two Years: NPV = -41,310								
Present	0	0	0	0	0	0	0	0
1	0	0	3,420	3,397	1,977	0	-1,443	-1,312
2	0	0	3,420	2,718	1,780	0	-1,640	-1,355
3	9,858	9,600	100	8,000	5,133	0	-14,425	-10,838
4	11,041	8,417	200	14,400	6,675	0	-12,983	-8,868
5	12,366	7,092	2,100	11,520	6,006	0	-15,552	-9,657
6	13,850	5,608	2,520	9,216	5,030	0	-16,948	-9,567
7	15,512	3,946	2,835	7,373	4,105	0	-18,188	-9,333
8	17,373	2,085	3,150	5,898	3,229	40,000	20,621	9,620

[a]Tax Savings are equal to 0.29 x (Loan Interest + CCA + Repairs)
[b]Net Cash Flow is equal to (Salvage Value + Tax Savings - Loan Principal - Loan Interest - Repairs)
[c]Discounted Cash Flow is equal to Net Cash Flow x $(1.10)^{n}$ where n is the year.

Cost Allowance. The impact on income taxes depends, of course, on the actual purchase price as well as the farmer's level of taxable income.

New machines have an advantage with respect to warranties and other legal protection. Manitoba farmers purchasing new machinery are protected under the Manitoba Farm Machinery and Equipment Act. This piece of legislation provides safeguards in several areas relating to machinery purchases, including guarantees concerning the minimum warranty terms that must be provided, the availability of repair parts, repossession procedures and arbitration of disputes.

In contrast, farmers purchasing used machinery have limited protection. The Manitoba Farm Machinery and Equipment Act does not cover used equipment except in cases where there is danger of repossession due to default of payments. Used machinery purchased from an equipment dealer is covered by the Consumer Protection Act (if the purchase price is no greater than $25,000) and the Sale of Goods Act. These pieces of legislation, however, do not provide much protection with respect to warranties. Their basic purpose is to ensure that the buyer is aware of what he/she is receiving and exactly what it will cost. There are also some provisions allowing for the rejection of goods if defective, and provisions limiting the procedures that may be used to repossess machinery. Farmers purchasing used equipment at an auction have virtually no protection under the law with respect to warranties, etc.

Finally, farmers purchasing used machinery must be wary of liens on the machinery from previous owners. The buyer must take care to ensure that no such liens exist. This may be done through a search of the Personal Property Registry.

Financing Options

Machinery purchases often require some degree of debt financing. The amount and cost of this financing can determine the feasibility of the machinery investment. There are several aspects of the financing decision that should be considered in conjunction with the overall machinery investment decision. **In particular, where will financing be obtained, at what terms will it be obtained, and how much will it cost?**

The farmer usually has two options for financing his/her machinery purchase; a bank or similar institution, and dealer credit. Each source has potential advantages. Banks can offer a wide range of services in addition to the acquisition of credit. If the farmer deals with the same bank for all his/her financial matters a good working relationship between lender and borrower often results, making the loan acquisition process much easier. The interest rates charged by banks may be fixed, or may change through the life of the loan. The repayment period of the loan, as well as the repayment schedule, are often negotiable.

The major advantage in using dealer financing is the possibility of obtaining more advantageous financing terms. One way in which competing machinery companies attempt to increase their sales is to offer attractive dealer financing. This may take the form of reduced interest rates, initial interest free periods, etc. The terms may be more attractive than those offered by banks. The interest rate associated with dealer financing is usually fixed for the term of the loan. There is often some

flexibility in the length of the repayment period, or the repayment schedule.

The costs of borrowing money include interest charges as well as any non-interest costs. These non-interest costs include service charges, transaction fees, charges for credit checks and insurance premiums required as a condition of receiving the loan. Generally, each loan payment consists of principal and interest. The principal portion is not considered a cost of the loan, but simply the return of borrowed capital to its owner. There are several factors with respect to the terms of the loan which affect the actual cost to the farmer of acquiring the credit. These factors include the interest rate for the loan, the type of amortization, the length of the repayment period, and the repayment schedule.

An obvious factor that affects the cost of an amortized loan is the interest rate. Lower interest rates result in lower total interest charges. The farmer is not likely to have much control over the interest rate offered by a particular lender. Interest rates may differ between alternative lenders, however, and should be an important concern in deciding upon the source and method of financing.

The type of amortization associated with the machinery loan also affects the farmer's cost of credit. An amortized loan may be defined as a loan involving periodic principal and interest payments. There are two types of amortization often utilized for agricultural loans. The first type involves equal total payments, where all periodic payments of principal and interest are equal. As the loan is paid off, the principal portion of each payment increases while the interest portion decreases. The other type of amortization is referred to as equal principal payment. If loan payments are calculated using this type of amortization, the principal portion of each payment remains constant over time while the interest portion decreases. As a result, the loan payments (principal plus interest) decrease during the life of the loan.

If two loans have identical terms except for the type of amortization, the loan with equal principal payments will cost less in terms of the total interest paid over the life of the loan. In order to obtain this lower cost the farmer must be able to make higher total payments early in the life of the loan than is the case for loans with equal total payments.

The period of time over which the loan is repaid affects the cost of the loan. A shorter repayment period results in a less expensive loan, in terms of total interest charges. For example, a loan repaid over five years will result in lower total interest charges than a similar loan repaid over seven years. However, a shorter repayment period results in greater periodic loan payments.

The repayment schedule of a loan affects the cost of the loan. The cost of a loan will decrease as the number of payments per year increases, for loans that otherwise have similar terms. For example, a loan repaid with monthly payments will result in lower total interest charges than a similar loan repaid with annual payments.

Table 8 provides an example of how the terms of a loan affect its cost. The annual and total principal and interest payments are provided for a $50,000 machinery loan. The initial set of terms involve repayment in five equal payments with a 12 percent interest rate. Each annual payment is equal to $13,870.49. The total cost of this loan over the five years is $19,352.44 in interest charges.

Table 8

Effects of the Loan Terms on the Cost of a $50,000 Machinery Loan

Type of Amortization	Loan Length	Repayment Schedule	Interest Rate	Year 1		Year 2		Year 3	
				Principal	Interest	Principal	Interest	Principal	Interest
Equal Payment	5 Years	Annual	12%	7,870.49	6,000.00	8,814.95	5,055.54	9,872.74	3,997.75
Equal Principal	5 Years	Annual	12%	10,000.00	6,000.00	10,000.00	4,800.00	10,000.00	3,600.00
Equal Payment	4 Years	Annual	12%	10,461.72	6,000.00	11,717.13	4,744.59	13,123.18	3,338.54
Equal Payment	5 Years	Monthly	12%	7,764.51	5,582.16	8,749.25	4,597.40	9,858.86	3,487.81
Equal Payment	5 Years	Annual	11.5%	7,949.09	5,750.00	8.863.23	4,835.86	9,882.51	3,816.58

Table 8 (Continuation)

Effects of the Loan Terms on the Cost of a $50,000 Machinery Loan

Type of Amortization	Loan Length	Repayment Schedule	Interest Rate	Year 4		Year 5		Total Principal	Total Interest
				Principal	Interest	Principal	Interest		
Equal Payment	5 Years	Annual	12%	11,057.47	2,813.02	12,384.36	1,486.13	50,000.00	19,352.44
Equal Principal	5 Years	Annual	12%	10,000.00	2,400.00	10,000.00	1,200.00	50,000.00	18,000.00
Equal Payment	4 Years	Annual	12%	14,697.97	1,763.75	0.00	0.00	50,000.00	15,846.88
Equal Payment	5 Years	Monthly	12%	11,109.24	2,237.45	12,518.14	828.51	50,000.00	16,733.33
Equal Payment	5 Years	Annual	11.5%	11,018.99	2,680.10	12,286.18	1,412.91	50,000.00	18,495.45

Table 8 also provides information for the same loan with alternative terms. If the type of amortization is changed to equal principal payments, total annual payments range from $16,000 in the first year to $11,200 in the fifth year. Total interest charges, relative to the initial situation, decrease to $18,000 over the life of the loan. If the repayment period is decreased from five to four years, annual payments increase to $16,461.72. Total interest charges again decrease, however, to $15,846.88. If the loan is repaid in 60 equal monthly payments of $1,112.22 rather than five annual payments, total interest charges over the life of the loan are reduced to $16,733.33. The last adjustment made in the loan terms is a reduction of the annual interest rate from 12 percent to 11.5 percent. Not surprisingly, annual payments are reduced to $13,699.09 and total interest charges are reduced to $18,495.45.

It is obvious, therefore, that the financing terms should be considered in the decision to acquire machinery services. The cost of the loan is a component of total fixed costs associated with machinery ownership. The choice of financing terms should be made in conjunction with the decisions concerning the size of machine to acquire, whether to purchase or lease, etc. The terms of the loan may be incorporated into the net present value analysis used to evaluate alternative machinery options. All costs, including interest and non-interest charges, should be included.

Protection for Machinery Financing

There are many risks associated with the purchase of machinery. For the farmer, there is the risk of purchasing defective equipment and the potential for problems with the availability of maintenance and repair parts. There is also the risk of defaulting on loan payments and subsequent repossession of machinery. For lenders, there is the risk of losing some of their investment through defaulted loans. This may result in farmers having more difficulty in obtaining the necessary credit from lenders. Fortunately, there are several pieces of legislation which are designed to offer protection to both farmers and lenders. This section introduces some of the provisions associated with these pieces of legislation.

One of the more important pieces of legislation with respect to machinery investments is the Manitoba Farm Machinery and Equipment Act. This Act provides protection primarily for farmers purchasing new machinery, although it also provides some limited repossession protection for farmers purchasing used machinery from dealers.

The Manitoba Farm Machinery and Equipment Act contains provisions relating to several aspects of the machinery purchase. The minimum length of the warranty is specified, as well as the parts that must be covered by the warranty and those that are excluded. The Act provides guidelines concerning the availability of repair parts and service. The procedures to be followed by a lender in order to repossess a piece of farm machinery are outlined. Finally, the Act provides guidelines concerning the resolution of disputes between the farmer and the dealer or lender. Further details concerning the Manitoba Farm Machinery and Equipment Act may be obtained from the Farm Machinery Board.

Manitoba farmers purchasing farm machinery are provided with some legal protection through other pieces of

legislation. One of these is the Sale of Goods Act. This Act provides protection against defective goods. With respect to machinery purchases, the Sale of Goods Act allows a farmer to return the machinery if he/she discovers that the machine is not in satisfactory condition.

Another important piece of legislation is the Consumer Protection Act. Equipment purchased for $25,000 or less, and not covered by the Manitoba Farm Machinery and Equipment Act (i.e., used machinery), is covered by this Act. The Consumer Protection Act provides guidelines for repossession procedures and disclosure of financing terms. The Act provides some protection for farmers with respect to warranties. Compared to the protection for new machinery provided by the Manitoba Farm Machinery and Equipment Act, however, the protection from this legislation is minimal.

One other important piece of legislation is the Farm Improvement and Marketing Co-operatives Loans Act. This Act also provides legal protection. In this case the protection is for lenders, against possible losses from defaulted farm loans. This Act has the effect of making credit available to some farmers who otherwise would have difficulty obtaining financing for machinery investments.

Conclusion

This publication has discussed several issues regarding farm machinery decisions. In particular, the costs associated with owning and operating machinery have been introduced and discussed. Alternative forms of control for machinery services have been introduced. Other issues that should be considered, such as tax implications, machinery selection and sizing, machinery replacement, and financing decisions, have all been discussed in some detail. These are all important factors to be considered when making machinery investments. Finally, a budgeting procedure, referred to as capital budgeting, has been developed as a tool that is useful for evaluating many machinery decisions.

There are several Manitoba Department of Agriculture factsheets that have been developed in conjunction with this publication. These discuss topics such as machinery costs, alternative forms of machinery control, etc. In addition, they provide examples and worksheets for farmers to use when evaluating machinery investments. **Copies of these factsheets are available from Manitoba Department of Agriculture offices.**